Synthetic Media for Removal of 1,4-Dioxane From Groundwater

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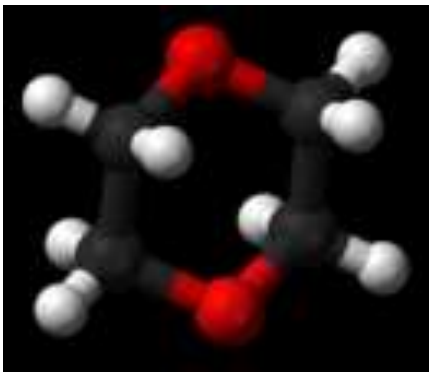
Presentation Outline

- Overview of existing treatment pump & treat technologies
- Challenges faced by these technologies
- Synthetic Media: an alternative solution
- How does it work? Where does it apply?
- Full-scale case studies
- Economics: comparison to existing technologies

Quick Refresher: Why is 1,4-Dioxane Such a Challenge to Treat?

- Miscible in water
- Low volatility, low sorption
- Difficult to measure
- Difficult to remediate (recalcitrant)
- Travels rapidly in subsurface; plume often extends beyond extraction wells
- **Once discovered, often the driver for cleanup**



1,4-Dioxane Treatment Options

Biological

Air Stripping

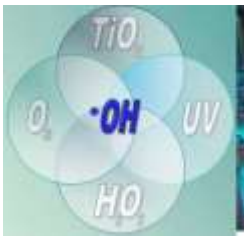
Advanced Oxidation

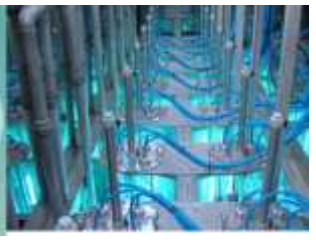
Synthetic Media (Resin)

Reverse Osmosis

GAC

AOP Treatment Systems





Challenges with Existing 1,4-D Pump & Treat Technologies (AOP)

- Struggle with variable influent loadings
- Delivery, storage and consumption of regulated chemicals (e.g. H_2O_2)
- Frequent change-out of UV lamps
- Bromate and hex chrome formation potential
- TSS/turbidity/TDS reduces effectiveness
- Subject to free radical scavengers
- pH-sensitive
- Mixed full scale results

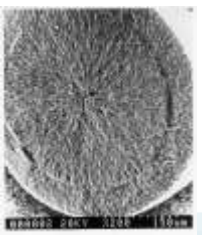
Alternative Solution: Synthetic Media

Derived from plastics, Synthetic Media can be used to collect various contaminants from liquids, vapor or atmospheric streams and be reused indefinitely

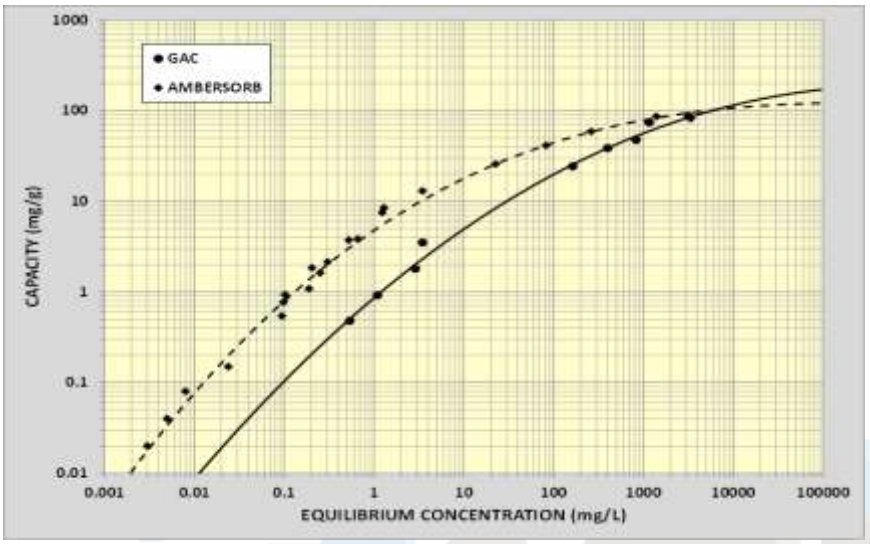
AMBERSORB™ 560

Unique Properties of Dow's AMBERSORB™ 560

- Hydrophobic
- Unique pore size distribution
- High affinity for organic compounds: (**simple** adsorption mechanism)
- Can achieve non-detect effluent concentration at substantial loading rates
- Can typically reuse (regenerate in-place) indefinitely
- Durable structure



AMBERSORB vs. GAC



AMBERSORB 560
Removal to ppb or Sub-ppb Levels

BTEX	DDE
PCE	Alachlor
TCE	1,4-Dioxane
1,1-DCE	MtBE
1,1,1 TCA	DFP (Diisopropyl Fluoro Phosponate)
1,2-DCA	DMMP (Dimethyl Methyl Phosphonate)
DCM	2,4-D
cis-1,2-DCE	Cresol
VC	IPA
Acetone	Permethrin
MEK	Dicofol
MIBK	Endrin
Phenol	Toxaphene
Chlorophenol	Heptachlor
Dichlorophenol	Aniline
Trichlorphenol	Pyridine
Aldrin	Caprolactam
Dieldrin	Ethyl Acetate
DDT	Triton X100

First Ambersorb System for Groundwater: Lake Charles, LA

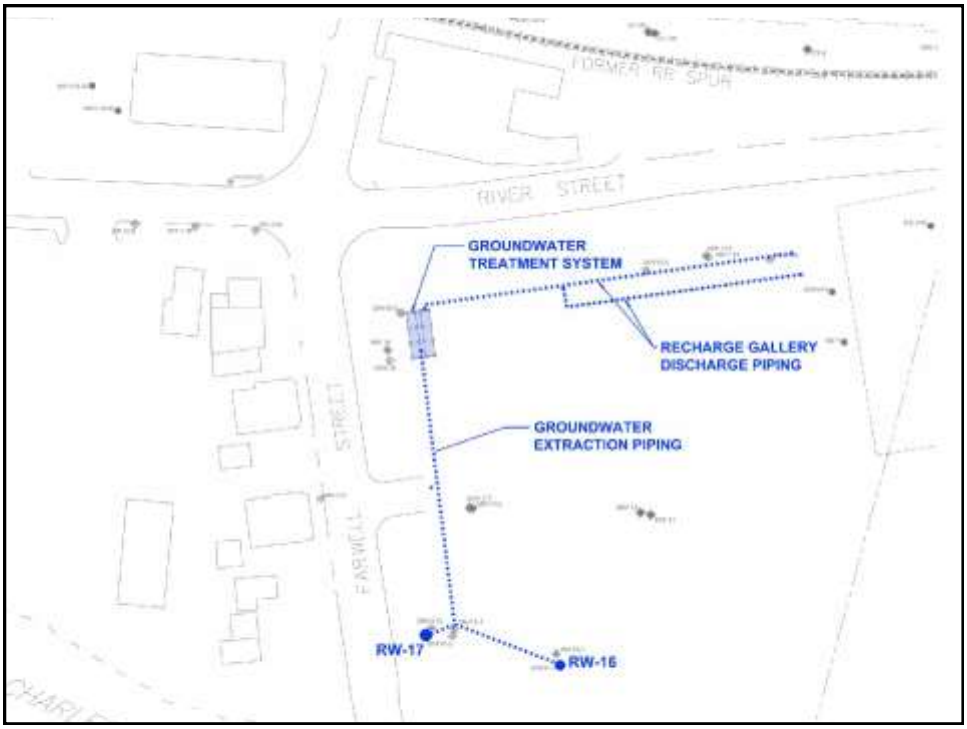
- Operating Since 1999
- Treating 1,2-DCA from > 2,000,000 ppb to ND @ 5 ppb
- Recovery and reuse!
- 15 years of loading and regenerating media
- No replacement of media

Animated Process Flow Diagram

- http://craesay.squarespace.com/storage/ect/Process_Flow.html

Case Study

- Site located in Waltham, Massachusetts
- Contaminated groundwater remediation
- Design basis
  - Flow = **15 gpm**
  - 1,4-dioxane = **20 - 60 µg/l**
  - Total Chlorinated VOCs = **2,000 – 9,000 µg/l**
- Modular system design for future relocation
- 1,4-dioxane permit limits
  - Originally 3.0 µg/l
  - **Now 0.3 µg/l**

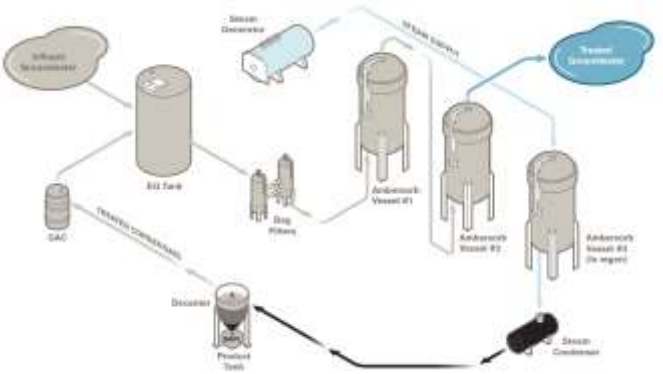


Project Objectives

1. Provide long-term contaminant migration control
2. Achieve compliance with present and future permit limits
3. Learn from this smaller system in anticipation of replacing an existing, upgradient 100-gpm air stripper

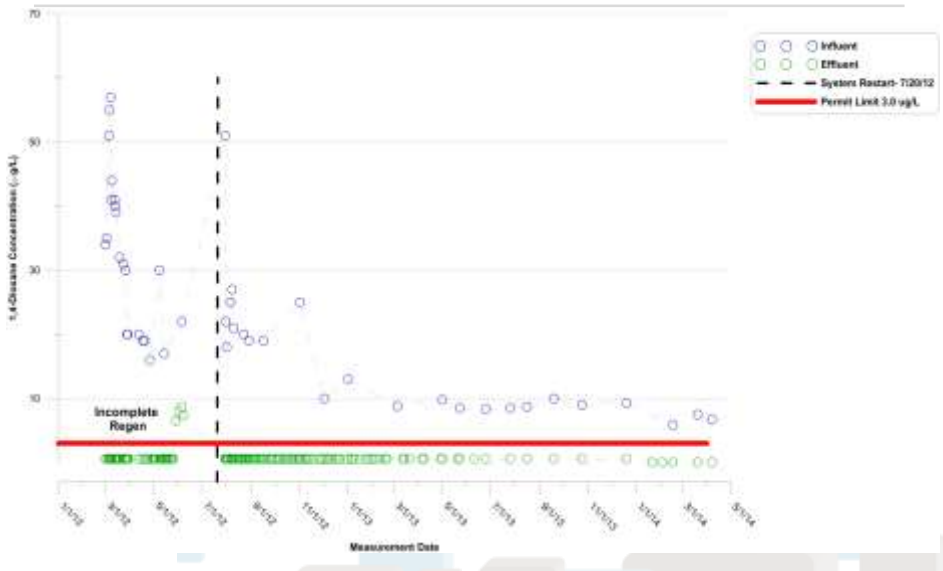
Project Thesis Statement:

Installing a synthetic media system will allow reliable, consistent compliance with low 1,4-dioxane standards, today and into the future.

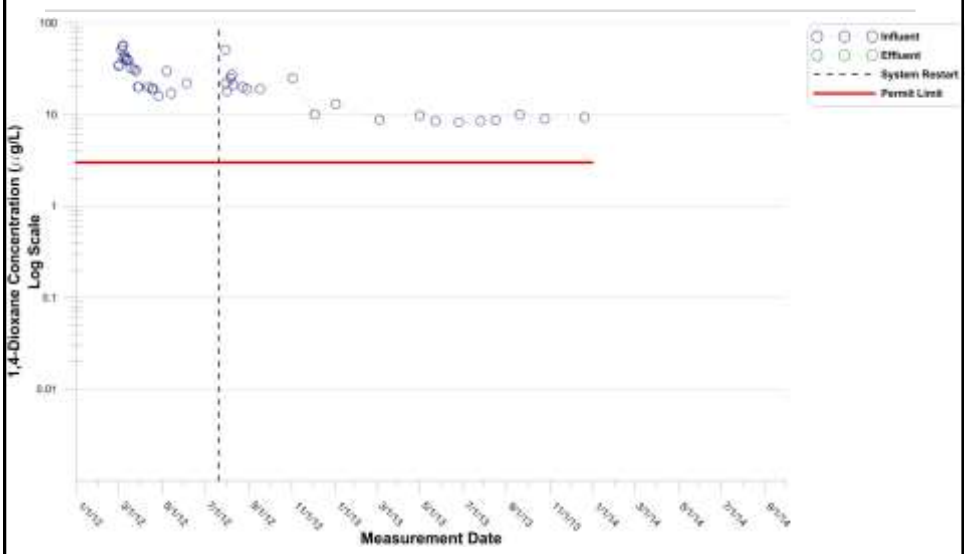


Modular System Design

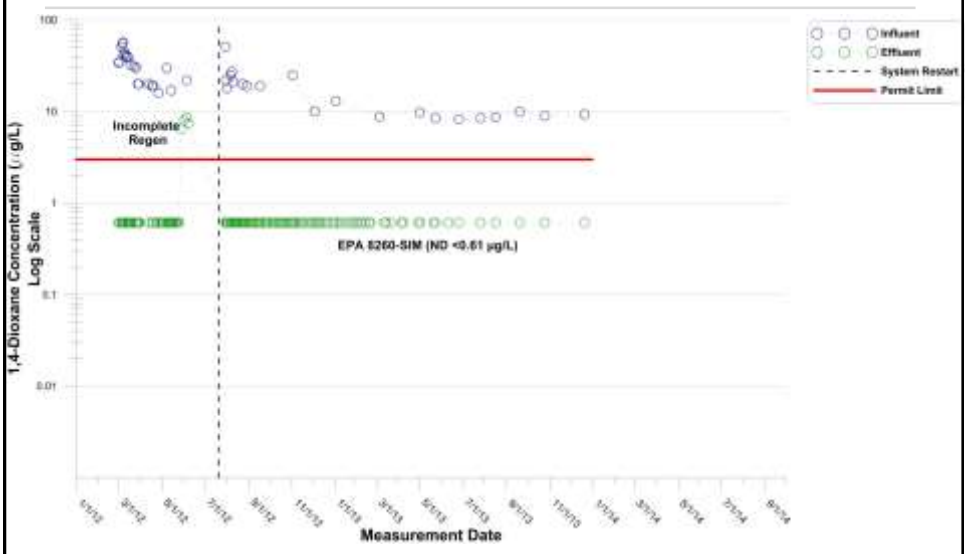
Influent and Effluent 1,4-Dioxane



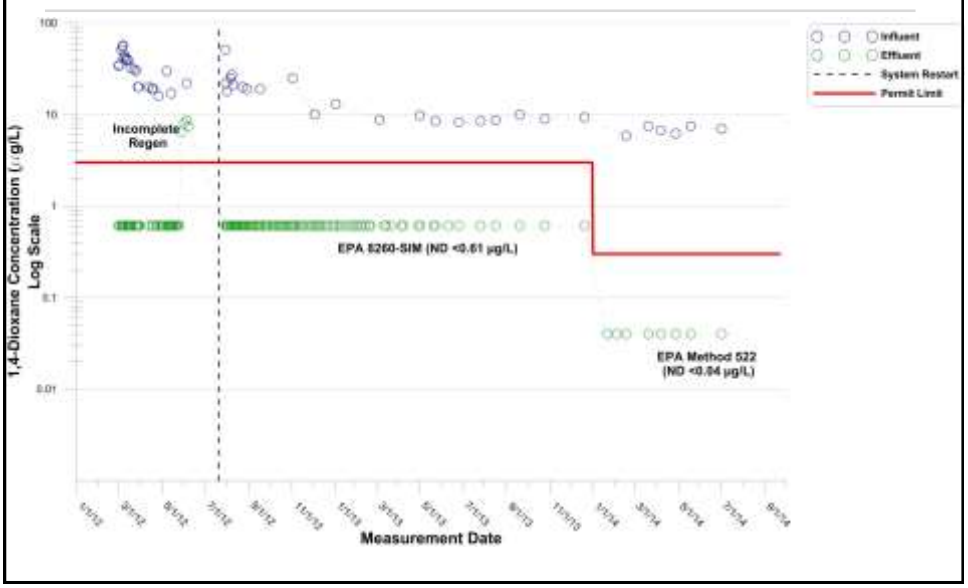
Influent 1,4-Dioxane



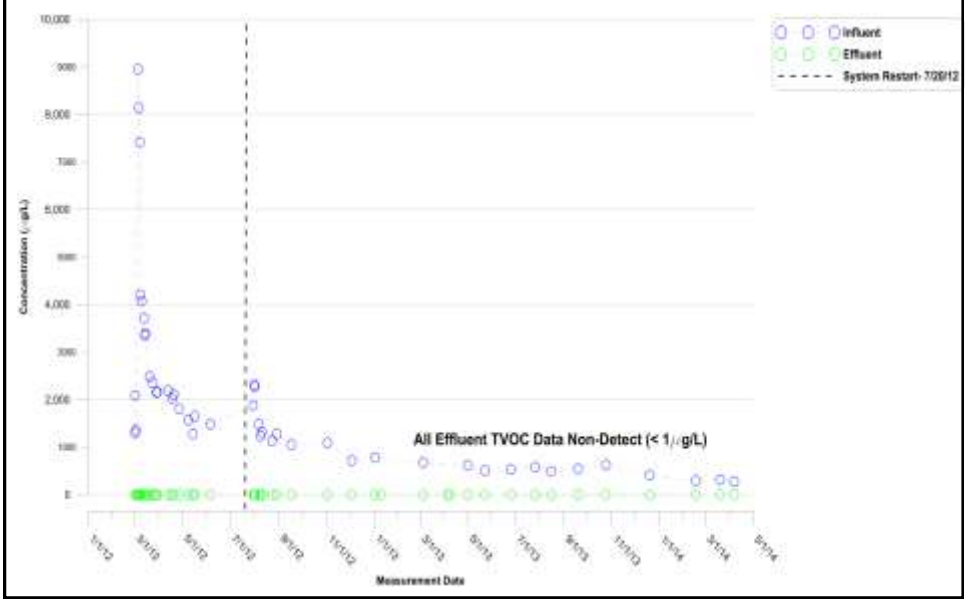
Influent and Effluent 1,4-Dioxane



Influent and Effluent 1,4-Dioxane



Influent and Effluent TVOCs



Lessons Learned

- Need to fully regenerate media
- Materials of construction: low pH of condensate
- Consider local boiler requirements
- Small, dedicated Synthetic Media team improves communication and execution: the birth of ECT
- Synthetic Media systems are robust and dependable

Summary

- Long-term contaminant migration control 
- Consistent, **reliable** performance, regardless of changing influent conditions
- No stranded capital. Consistently less than new 0.3 µg/l limit without having to upgrade system
- Several valuable lessons learned
- Now applying the lessons from this successful installation in operation of larger, 100-gpm synthetic media system on site (closer to the source area)

Waltham 100-gpm System

St. Petersburg, FL
A Unique Approach to Iron Management

- Phase 2: Long-term plume control
- Design Basis:
  - Flow = **100-175 gpm**
  - 1,4-dioxane = **2,535 ppb**
  - Total Organics = **17,450 ppb**
  - Iron = **6-30 mg/l**

Iron Pretreatment = Half the Battle

Iron Pretreatment

Ambersorb Vessels

Iron Sludge Dewatering

Plate and Frame Filter Press

Iron Sludge

Oxidation State Matters

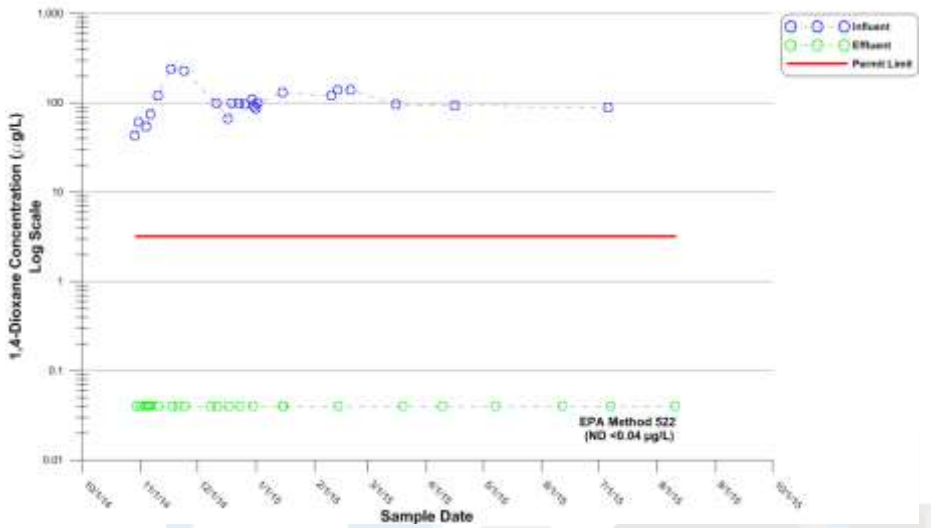
- If you see water containing only ferrous iron, the iron will be totally dissolved and the water will appear as crystal clear, no mater what pH it has. The situation is different with ferric iron. At a pH greater than 3.5, ferric iron is insoluble.

Ferrous Iron

Ferric Iron

Amersorb Vessels are Zero-headspace

Influent and Effluent 1,4-Dioxane



Bench & Pilot Testing

Pilot Skid Operating in Westville, IN

Full-Scale Mobile Demonstration Unit

Clifton Springs Skid: Treating cVOCs and 1,4-D

Summary

- 1,4-Dioxane is challenging to treat
- Permit limits are trending downward
- AOP systems dominate the existing pump & treat installations, but have their limitations
- AMBERSORB provides a reliable treatment alternative
  - Early bugs have been worked out
  - Adsorption = simple
  - Media can be regenerated in-place, enhancing sustainability
  - Results have been consistent/dependable
  - Like AOP, AMBERSORB systems can be skidded, containerized and mobile
  - Addresses the issue of stranded capital
- Capital costs are higher than AOP; O&M costs are lower

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